18. Formulate the problem of simple pendulum and hence derive equation motion of a simple pendulum by applying Hamilton equation of motion.

19. Using the method of small oscillations, calculate the frequencies of vibrations of linear triatomic molecules.

20. Derive Lorentz transformation equations.

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NOVEMBER/DECEMBER 2023

23PPH12 — CLASSICAL MECHANICS AND RELATIVITY

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Why is the transformation equation necessary?

2. Outline the advantages of using generalized coordinates.

3. What do you understand by conservative system?

4. Interpret Atwood's machine. Mention its application.

5. Define cyclic coordinates.

6. When is linear momentum of a particle conserved?

7. When is a system said to be under stable equilibrium?

8. What are called normal modes of vibrations?

9. Compare inertial and non-inertial frames.

10. Comment on mass-energy equivalence.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Show that the angular momentum is conserved on a system of N particles when there is no external torque acting on it.

Or

(b) Interpret virtual displacement and virtual work.

12. (a) State and Prove D' Alembert's principle. Give its one application.

Or

(b) Apply Lagrangian equation of motion to determine the equation of motion of linear harmonic oscillator.

13. (a) Derive Hamilton's canonical equations of motion from Hamiltonian function.

Or

(b) Apply Hamiltonian equation of motion to solve the problem of one dimensional harmonic oscillator.

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14. (a) Formulate problem of small oscillations and hence derive Lagrange's equation of small oscillations.

Or

(b) Obtain the equation of motion of the parallel pendulum.

15. (a) Demonstrate the theory of relativistic addition of velocity law and hence prove that the velocity of a relativistic particle cannot travel beyond the velocity of light at vacuum.

Or

(b) Extend the concept of special theory of relativity to discuss length contraction and time dilation.

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. What are constraints? How is it helpful in studying mechanics of particles? Distinguish between holonomic and non-holonomic constraints with an example.

17. Obtain Lagrange's equation of motion and show that these can be written as $\frac{d}{dt}\left(\frac{\partial L}{\partial q_j}\right) - \frac{\partial L}{\partial q_j} = 0$ for a conservative system.